FISH STRANDING CAUSED BY A TYPHOON IN THE VICINITY OF SETO[1)]

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With 1 Text-figure and 2 Tables

Typoon No. 23 attacked through the eastern part of Shikoku Island on September 10, 1965, and our laboratory was included in the range of the severe storm. After the storm went away, still the sea was very rough, Mr. S. MORIYAMA of the laboratory aquarium found many people of this vicinity walking around the southern beach of the laboratory searching for stranded fishes. Thinking of the possibility that some fishes might be alive and available for the aquarium exhibition, we went down to the beach and participated in fish searching. Although the usual food fishes such as *Epinephelus fario*, *Girella punctata*, *Sebastiscus marmoratus*, etc., were picked up by the people already, we engaged ourselves in more careful collecting along the beach of about 300 meters long and about 30 meters width. In two hours, we collected most of the stranded fishes left there, which filled up our three backets.

Collected specimens were damaged unexpectedly slightly except for their epidermis or scales; their fins were in a nearly perfect condition. Several individuals were still alive and were brought into the sanitary tank of the aquarium, though unfortunately they could not be cured of the fatal damages of epidermis.

Careful sorting of these fishes showed that 976 specimens of 51 different species were included in the collection. Of these, 12 species (species Nos. 16, 23, 24, 26, 30, 32, 33, 35, 39, 40, 44 and 47 in Table 2) are newly recorded from the coast of Wakayama Prefecture. Of six unidentified species, a few seem even to be new to science.

Accord'ng to M. BRONGERSMA-SANDERS 1957, the mass mortality of marine organisms caused by severe storms has been reported infrequently, and she reports only two cases of fish stranding by storms; one occurred in Iceland in 1821 and the other occurred in England in 1874. Many other cases of mass

1) Contributions from the Seto Marine Biological Laboratory, No. 453.

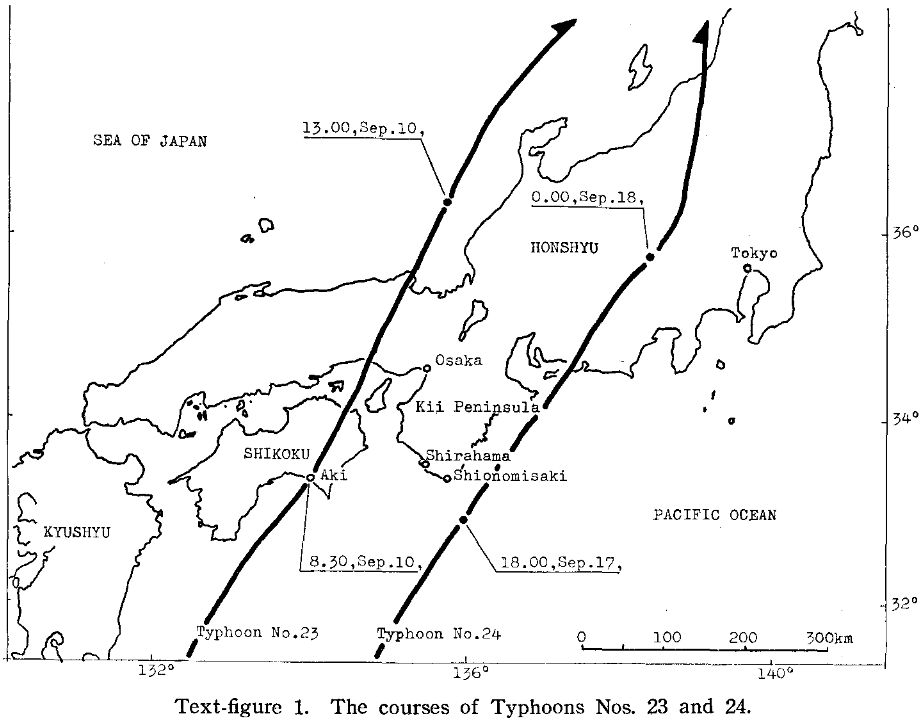
mortality have been caused by noxious water blooms, sudden changes in water temperature or salinity, tectonic earth and seaquakes and vulcanism. In our country, also, the mass mortality of sea fishes has been mainly caused by sudden change in water temperature, and there is no record of fish stranding caused by typhoons, though some cases of the stranding of molluscan shells at storms are reported.

Even if a considerable amount of fishes are damaged by a typhoon, in order for fish to be actually stranded on the beach many factors such as the stage of the tide, wave diretion and height, direction and velocity of wind, and the topographical elements of the beach must be combined satisfactorily.

Before going further, we wish to express our hearty thanks to Prof. H. UTINOMI and Dr. T. TOKIOKA of the laboratory, and Dr. R. BIERI of Antioch College, U. S. A. for their kindness in reading the manuscript. Also our sincere gratitude to Mr. S. NISHIMURA of the laboratory and Mr. K. NISHI of the Disaster Prevention Research Institute of Kyoto University for their kindness in offering us valuable data.

The outline of Typhoon No. 23

The course of Typhoon No. 23 is shown in Text-figure 1. The storm



Text-figure 1. The courses of Typhoons Nos. 23 and 24.

zone was about 200 km in radius, the minimum air pressure was 950 mb and the maximum velocity of the wind was 68 m/sec when it landed at Aki, a city on the southern coast of Shikoku Island.

Swells arose in the vicinity of our laboratory on the 7th of September and grew stronger day by day. On the early morning of the 10th, the strong wind was blowing from south east and violent waves were attacking the beach. Around 10.00 h, the wind turned from south to west and went down gradually. The records of tides and waves from September 8 to 11 are shown in Table 1. The minimum air pressure and the maximum velocity of wind recorded in our district were 978 mb and 25.1 m/sec respectively.

Table 1. Tides and waves recorded at the Shirahama Oceanographic Tower Station of Kyoto University in the Bay of Tanabe.

date	high tide		low tide		wave			
	time	level (cm)	time	level (cm)	time		cycle (sec)	height (cm)
Sept. 8	03.59	173	10.47	48				
	17.26	189	23.16	104	12.00	mean	13.2	13.8
						max.	13.0	55.8
9	04.38	183	11.17	43	0.00	mean	13.6	70.0
						max.	13.7	109.0
	17.47	196	23.39	93	12.00	mean	13.2	116.0
						max.	13.3	184.8
10	05.13	193	11.45	39	0.00	mean	14.3	198.3
						max.	13.4	272.4
	18.08	201	—	—	12.00	mean	14.0	161.0
						max.	13.9	222.6
11	05.47	201	00.03	83	0.00	mean	10.7	55.6
						max.	11.3	85.8
	18.30	204	12.12	38				

Stranded fishes

Names, sizes and number of stranded fishes are shown in Table 2. Captions used in Table 2 are: In the column of specimen number, "+" means that occurrences were confirmed by examining fishes collected by persons other than us. In the column of habitat, "A" shows that those fishes have been observed actually by us with SCUBA in the shallow waters less than 20 m deep around the reef or over the rocky bottom. "B" shows the fishes inhabiting the rocky or sandy bottom near the coast, but being never observed by us; their usual living layer may be deeper than 20 m. "C" shows so-called deep sea fishes. "D" indicates that the exact habitats of the fishes

Table 2. List of stranded fishes.

sp. No.	Species		total length (mm)			number	%	habitat			
			min.	max.	mean			A	B	C	D
1	*Plotosus anguilaris* (LACÉPÈDE)	ゴンズイ	66	221	128	5	0.5	○			
2	*Conger japonicus* BLEEKER	クロアナゴ			285	1	0.1		○		
3	*Rhyncocymba nistromi nistromi* (JORDAN & SNYDER)*	ギンアナゴ	161	225		2	0.2			○	
4	*Aulostomus chinensis* (LINNE)	ヘラヤガラ				+			○		
5	*Hippocampus japonicus* KAUP	サンゴタツ			31	1	0.1		○		
6	*Paratrachichthys prosthemius* JORDAN & FOWLER*	ハリダシエビス			86	1	0.1			○	
7	*Holocentrus spinosissimus* (TEMMINCK & SCHLECEL)	イットウダイ				+			○		
8	*Leiognathus nuchalis* (T. & S.)	ヒイラギ	34	80		2	0.2		○		
9	*Apogon taeniatus* CUVIER	ヨコスジイシモチ			127	1	0.1	○			
10	*Apogon cyanosoma* BLEEKER	キンセンイシモチ	66	93	73	10	1.0	○			
11	*Apogon endekataenia* BLEEKER	コスジイシモチ	70	113	84	12	1.2	○			
12	*Apogon doederleini* JORDAN & SNYDER	オオスジイシモチ	91	131	116	49	5.0	○			
13	*Apogon semilineatus* T. & S.	ネンブツダイ	85	115	97	14	1.4	○			
14	*Apogon notatus* (HOUTTUYN)	クロホシイシモチ	82	120	100	5	0.5	○			
15	*Apogon erythrinus kominatoensis* EBINA*	コミナトイシモチ	38	137	73	45	4.3		○		
16	Apogonidae sp.*				104	1	0.1				○
17	*Aulacocephalus temmincki* BLEEKER	ルリハタ	132	192		2	0.2	○	○		
18	*Epinephelus fario* (THUNBERC)	ノミノクチ				+					
19	*Sacura margaritacea* (HILGENDORF)	サクラダイ	56	102	88	10	1.0	○	○		
20	*Franzia squamipinnis* (PETERS)	キンギョハナダイ	50	105	83	16	1.6	○			
21	*Girella punctata* GRAY	メジナ				+		○			
22	*Plectorhynchus pictus* (HILGENDORF)	コロダイ				+					
23	*Isobuna japonica* (STEINDACHNER & DÖDERLEIN)*	イソブナ	30	35	33	6	0.6				○
24	Opisthognathidae sp*				95	1	0.1				○
25	*Brotula multibarbata* T. & S.	イタチウオ				1	0.1	○		○	
26	*Grammonus robustus* SMITH & HADCLIFFE*	セムシイタチウオ			262	1	0.1				
27	*Vireosa hanae* (JORDAN & THOMPSON)	ハナハゼ	61	98	87	11	1.1	○			
28	*Zonogobius boreus* SNYDER	ミサキスジハゼ			87	1	0.1	○			
29	*Zonogobius eugenius* (J. & F.)*	ベンケイハゼ			59	1	0.1		○		
30	*Callogobius hasselti* (BLEEKER)*	オキナワハゼ	66	75	29	2	0.2		○		
31	*Pterogobius elapoides* (GÜNTHER)	キヌバリ				+		○			
32	Gobiidae sp.*				83	1	0.1				○
33	Gobiidae sp.*				93	1	0.1				○
34	*Amphiprion xanthurus* (CUVIER & VALENCIENNES)	クマノミ				+		○			

Table 2. continued

sp. No.	Species		total length (mm) min.	max.	mean	number	%	habitat A	B	C	D
35	*Chromis mirationis* TANAKA*	トウカイスズメダイ			67	1	0.1	○			
36	*Chromis notatus* (T. & S.)	スズメダイ	118	152	133	13	1.3	○			
37	*Chromis xanthochir* (BLEEKER)	コガネスズメダイ	67	147	107	3	0.3		○		
38	*Parapomacentrus nigricans* (LACÉPÈDE)	クロソラスズメダイ	61	110	91	29	3.0	○			
39	*Abudefduf vaigiensis* (QUOY & GAIMARD)	オヤビッチャ				+		○			
40	*Abudefduf richardsoni* (SNYDER)	オキナワスズメダイ	108	111		2	0.2	○			
41	*Halichoeres tenuispinnis* (GÜNTHER)	ホンベラ	96	129		2	0.2	○			
42	*Cirrhilabrus temmincki* BLEEKER	イトヒキベラ		123		1	0.1	○			
43	*Cheilinus bimaculatus* C. & V.	タコベラ	81	112	102	3	0.3	○			
44	*Cheilinus* sp.*				102	1	0.1		○		
45	*Callyodon ovifrons* (T. & S.)	アオブダイ				+		○			
46	*Centropyge fisheri* (SNYDER)*	レンテンヤッコ	73	147	100	8	0.8		○		
47	*Balistes* sp.*				60	1	0.1		○		
48	*Stephanolepis cirrhifer* (T. & S.)	カワハギ	112	151		2	0.2	○			
49	*Brachaluteres ulvarum* J. & S.	アオサハギ			71	1	0.1	○			
50	*Ostracion tuberculatus* LINNE	ハコフグ	102	175	140	5	0.5	○			
51	*Lactoria diaphanus* (BLOCH & SCHNEIDER)	ウミスズメ	119	242	158	15	1.5	○			
52	*Lactoria fornasini* (BLANCONI)	シマウミスズメ	23	118	71	192	19.9	○			
53	*Canthigaster valentini* (BLEEKER)	シマキンチャクフグ			71	1	0.1	○			
54	*Canthigaster vivulatus* (T. & S.)	キタマクラ	57	150	78	23	2.4	○			
55	*Fugu pocilonotus* (T. & S.)	コモンフグ				+		○			
56	*Sebastiscus marmoratus* (C. & V.)	カサゴ	114	170	150	11	1.1	○			
57	*Scorpaenodes littoralis* (TANAKA)	イソカサゴ	34	103	71	441	45.3	○			
58	*Brachirus zebra* (Q. & G.)	キリンミノ	80	102	95	3	0.3	○			
59	*Physiculus japonicus* HILGENDORF	チゴダラ	176	177		2	0.2			○	
60	*Antennarius sanguifluus* JORDAN	ベニイサリウオ	40	261	101	14	1.4	○			
61	*Antennarius tridens* (T. & S.)	イザリウオ			233	1	0.1		○		
				total		976	100.0	37	15	4	5

are unknown. The asterisk after the name indicates that those fishes have never been kept in our aquarium

As seen in Table 2, most fishes, 83.6% in number of species and 98.3% in number of specimens, are inshore inhabitants. And further, 59.0% of the whole species are observed actually by us in the waters shallower than 20 m. Thus, it is clear that the damage to fishes by Typhoon No. 23 was mainly done on shallow water reef fishes, since deep water fishes are only 6.6% in species number and 0.6% in number of specimens. It is very strange, that such common reef fishes as *Pempheris japonicus* DÖDERLEIN, *Goniistius zonatus* (CUVIER & VALENCIENNES), *Pomacentrus coelestis* JORDAN & STARKS, *Talassoma cupido* (T. & S.), *Pseudolabrus japonicus* (HOUTTUYN), *Chaetodon collaris* BLOCH and *Prionurus microlepidotus* LACÉPÈDE, which are usually observed by SCUBA divers in this vicinity are not included in the present collection of stranded fishes and on the contrary that the dominant components of the present stranded fishes, *Lactoria fornasini* and *Scorpaenodes littoralis* are not met with so abundantly during our underwater observations.

It is of a great interest, also, that such deep water fishes as *Rhynchocymba nystromi nystromi*, *Paratrachichthys prosthemius*, *Grammonus robustus* and *Physiculus japonicus* which are recorded as inhabitants of the depth of more than 100 m were actually damaged and stranded.

To make these points clear, further observations on fish strandings by typhoon are indispensable.

A week after the visit of Typhoon No. 23, on the evening of September 17, Typhoon No. 24 passed off Shionomisaki at the tip of Kii Peninsula. Although No. 24 brought strong northern winds, they were not so strong as those of No. 23. The junior author collected 4 specimens of *Scorpaenodes littoralis* and a single specimen each of *Apogon cyanosoma*, *Ctenotripauchen microcephalus* (BLEEKER) and *Hypodytes rubripinnis* (TEMMINCK & SCHLEGEL) on the northern beach of the laboratory at this time. The last two are inhabitants of the shallow inshore waters in this district.

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